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ABSTRACT

This paper describes the development of a conceptual framework for conducting research using computer based interactive video and a generic disc as research tools. It is argued that computer based interactive video represents the beginnings of a truly computer based learning system. An altered version of the 1984 Grabowski and Whitney conceptual framework is presented as a way to guide thinking about the interaction of accountable components of instruction. The factors in this new framework that affect affective and cognitive outcomes--learner characteristics, content type, message design, and instructional strategies--are considered in relation to computer based interactive video and computer based learning systems. Proposed research is described that will be based on these factors. This research will use a series of visual and auditory stimulus materials pressed onto a videodisc to explore those learner characteristics for which message design can have a major impact. It is noted that the treatments for the various studies can be altered through the sequencing, selection of stimulus material, and the addition or reorganization of text. The framework is illustrated in a figure. (24 references) (EW)

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The Development of a Research Agenda and Generic Disc for Computer-Based Interactive Video

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Introduction

The purpose of this paper is to describe the development of a conceptual framework for conducting research using computer based interactive video (CBIV) and a generic disc as research tools. In 1977, Schramm advocated that "learning from the media...is an extremely complex multivariate process that challenges us, if we are to understand it, not to ask the simple questions, but rather to concern ourselves with the conditions for selecting one medium over another, for combining and for using media" (in Johnston, 1987, p. 3.). With the technological advances which converted interactive video to computer driven interactive video, it became obvious in the early eighties that designing instruction for this medium was much more complex since more variables could be called upon and combined to create a learning task. What became important, then, was the identification of, and theory-driven specification for, using those multivariate factors available within this more complex and powerful medium.

The Original Research Agenda

After analyzing the components of eight models presenting wholistic conceptions of student learning in classroom settings that were summarized by Hartel, Walberg, and Weinstein (1983), Glaser's model was selected. Glaser (1976) suggests that the design of instruction must account for the following four components:

- knowledge and skills required for performance,
- initial state of the learner,
- conditions to change the learner from an initial state to a state of competence, and
- short and long term outcomes of instruction.

Siegel and Siegel (1964) suggest that a framework serves as an instructional gestalt whose "special virtue is derived from the fact that the framework calls attention to, rather than ignores or minimizes the importance of, the complex nature of the educational process. It focuses research interest upon variables of interaction rather than upon the main effects" (p. 39). Following this suggestion, Grabowski and Whitney (1984) reconfigured the four components suggested by Glaser into a 3 dimensional matrix to function as the overall unifying conceptual framework to study learning with this medium. The three interacting dimensions consisted of the learner (aptitude, prior experiences, motivation, cognitive style, cognitive schema)/content (the content area and the level and type of objectives to be achieved)/instructional process (instructional, sequencing, and presentational strategies) with their interactions

affecting long and short term outcome. Overlying this matrix were media attribute choices (modalities, layout, flow, color, timing, volume, realism) available with the computer based interactive video medium which could then be selected for a specific type of learner, for a specific content area and outcome, using a specific strategy. Their goal was to use the framework to summarize current research results and identify gaps in that research with the final intent of developing prescriptions which link theory to the practice of selecting media attributes for CBIV.

At the same time, however, Clark (1983) joined other researchers to caution even more emphatically against conducting, or even advocating, more inappropriate media comparison research. His cautionary advice was also levied against this proposed framework. The intent of the conceptual framework, however, was NOT to focus on media, but rather on media attributes or the forms of instruction. Resolving whether this framework fell under inappropriate media research became extremely important before further work on the model was conducted. The resolution of this problem lies in exploring whether CBIV is, indeed, a unique delivery system and clarifying what type of variables do impact upon "instructional effectiveness."

The Appropriateness of CBIV Research

Viewing CBIV (unlike interactive video which lacks computer control) as one discrete medium is somewhat problematic. In some respects, even the term "CBIV" is inappropriate itself since it defines the technology in terms of only two media -- video and computer. CBIV is, in fact, an amalgam of many media connected and controlled by a computer, and thus, represents the beginnings of a truly "computer based" learning system (CBLS) which will continue to evolve for many years to come. Advances in communication technology have already begun to blur the distinctions between a number of delivery systems such as videotext, computer based learning and interactive video. Viewing CBIV within the larger context of a computer-based learning system is more realistic. Such a multifaceted, flexible and unique delivery system can have important implications for instructional research and instructional development.

First, a CBLS will allow the learner to direct the interaction with the instruction to a much greater extent and perhaps even to the point where the learner will generate his/her own goals and objectives. As Salomon (1986) suggests this technology will allow instruction to become increasingly self-guided, open-ended, and interactive. Therefore, learner variables such as attitude, previous knowledge, learning style will become increasingly important for instructional

researchers to investigate. Second, a CBLS system will conceivably allow instruction to take any form imaginable. Questions related to what delivery mode to use and how messages should be represented on a particular delivery mode suddenly become very important. Unfortunately, instructional design models afford the instructional developer relatively little guidance with regard to questions posed by learner characteristics or message design.

This argument leads into the the second issue which involves the clarification of the types of variables that impact upon "instructional effectiveness." The contention (Clark, 1983) that instructional design -- the selection of theory-based strategies that are intended to solve a particular instructional problem -- is the most important activity in the development process needs to be examined more fully. Typically, instructional developers never work from designs that stipulate all aspects of a finished instructional product. In fact, instructional designs are typically lists of strategy components that are deemed appropriate given a particular learning context (Reigeluth, 1983). For example, a design for a lesson that teaches students to classify animals as mammals might include a generality, a series of matched examples and non-examples, a sequence of examples that progresses from simple to complex, practice in classifying, and learner feedback. Reigeluth (1983) refers to such design documents as "blueprints" and describes the role of the instructional designer as akin to that of an architect.

The blueprint/architect is a bit misleading as it suggests a greater degree of fidelity between plan and finished product than actually exists. An obvious question emerges: what remains to be stipulated in addition to the strategy components listed in an instructional blueprint? If we follow the blueprint analogy (such as a blueprint of a house) a bit further, it is readily apparent that a great deal remains to be specified. The house plan is incomplete in a number of ways. The plan does not specify how the rooms should be finished -- what color, shade and texture of floor, wall and ceiling coverings to use. The plan does not specify what furniture to buy and where it should be placed. In short, our house plan merely lays out a shell. Other specifications need to be made in order to make the shell a useful and enjoyable place to live. In instructional terms, an instructional design does not even result in something as complete as the empty shell of a finished house. The major structural components of the lesson are in place but the components need much embellishment in order to yield an instructional product that will be effective and enjoyable for the learner. In essence, the blueprint prescribes the structure of the lesson but it does not prescribe the "form"

the lesson should take.

The instructional designer faces a myriad of questions related to the form of the finished instructional product. Instead of plaster and bricks, the instructional designer molds and crafts information into meaningful, effective and pleasing messages -- messages that contain both instructional content and instructional strategies. It is during this process of message design that life is breathed into instructional content and strategies so that a useful product results. The developer must not only decide what attributes to select but how the attributes are to be used. The instructional developer's job is further complicated when working with CBLS. One's choices are nearly unlimited. Errors at this stage -- such as poor screen layout -- result in a muddled, confusing and unappealing product and instructional design models offer very little guidance.

What is interesting about this discussion is that if the media attributes guidelines are stripped away, what remains is a two dimensional matrix of learner characteristics and content with the prescriptions being instructional strategies. This approach ignores the important prescriptive research of Chu and Schramm (1968), Fleming and Levie (1978), Winn (1987), Dwyer (1978), and Jonassen (1982) to name only a few. Research questions regarding form are vital to ask because of their perceived impact upon the "effectiveness" of instruction just as the form of a house will impact on quality of life. The questions regarding content and instructional strategies are important and necessary, but not sufficient as Kozma (1987) states in a recent discussion of this issue. Given that questions regarding the form of the message for various learner characteristics are legitimate to ask and that their answers would contribute to more "effective" instruction as this paper argues, guidelines are necessary, and research is needed to help formulate and validate them. The conceptual framework for CBLS and the CBLS itself are powerful tools for accomplishing just that.

The important and unique aspects of CBLS which make it a powerful tool for formulating those guidelines and conducting this research are important to highlight. The CBLS technology offers a means for carefully studying many instructional and media attributes acting in unison, and the means to "control for" the effects of specific attributes. The implications for research are numerous. For example, a CBLS unit could act as "both stimulus material and data collection device" (Chen, 1986, p. 27). In addition, the research control afforded by CBLS would reduce the likelihood of introducing confounding variables and would ease replication in various settings.

Therefore, the CBLS described here is indeed something new, cannot be described as one distinct medium to be compared with others, and the form available/unique to it warrants further study. The technology's ability to "abolish previous media distinctions" (Chen, 1986, p. 27) and to afford a high level of interactivity is unique. At the same time, the nature of a CBLS will force and enable researchers to examine issues related to learner characteristics and message form more closely and within a more controlled environment.

The Revised Agenda

Given, then, that CBLS message design research is appropriate as described, an altered version of the 1984 Grabowski and Whitney conceptual framework was developed to guide our latest thinking regarding the interaction of accountable components of instruction. This new framework includes learner characteristics, content type, message design, and instructional strategies as the important variables which affect affective and cognitive outcomes. (See Figure 1). As can be noted, learner, content, and instructional process variables are still reflected in this framework, however, the use of a branched flowchart rather than a matrix and the inclusion of message design as a discrete step rather than being overlaid onto the entire model mark the differences. This strategy more clearly reflects the decision process of instructional developers and will also facilitate the creation of an expert system to manage the subsequent development prescriptions, i.e. given a specific content type and instructional strategy, and most important learner characteristics which must be taken into account, message design principles would be selected.

Insert Figure One here.

As described earlier, instructional design models currently offer much guidance to designers for selecting instructional strategies for specific content and outcomes and are well researched. These two components are included in the framework because they are necessary elements, but will not be included specifically in this round of research questions. Therefore, content type and instructional strategy will be givens in the model and will not be varied. Learner characteristics continues to be the key component and remains at the core of the model with the other key feature

being message design variables. The purpose of the research agenda is to identify those learner characteristics for which message design can have a major impact. Variations in learner characteristics will be matched and varied with message forms to determine which of the many learner characteristics should be taken into account when developing an instructional message.

Using this structure, a select list of learner characteristics and message design were chosen for their potential for exploring the unique aspects of the computer based learning system. Three categories are included under learner characteristics:

- o the structure of memory,
- o cognitive style, and
- o modality preferences,

Under each of these broad categories of learner characteristics, specific characteristics of special interest were selected:

- o characteristics of the structure of memory
  - -cognitive engagement
  - -cognitive schema matching

- o cognitive style variables
  - -field dependence/independence
    - -organization of information
      - -(serialistic/wholistic,
      - - detailed/global)
    - -social/human aspects

- o modality strength of learning.
  - -message representation
    - -(static visual, auditory,
    - - dynamic, manipulative visuals)

Careful reflection of the special representational strengths of the CBL medium prompted the selection of 5 important variables:

- o interactivity,
- o easily accessed massive text and visual data bases,
- o graphic overlay,
- o video windows, and
- o alternate visual and audio forms.

Five areas of inquiry evolved from interrelating these learner characteristics and message design variables of the CBLS, and will be described next.

Interactivity and cognitive engagement. The interactive nature of the CBLS is a naturally powerful medium for cognitive engagement. Cognitive engagement entails much more that merely controlling pace and sequence. It assumes an active involvement of all stages of the memory, with special emphasis on the working memory. Through the working memory, students relate stimuli from the environment to information in long term memory, and are mentally active during this process. Simply controlling the pace of a lesson (press return to continue) or the sequence does not activate that extremely important activity of interacting with the material. While Hannafin et.al. (1985, 1986), Gay (1986), Carrier, (1985) and others are actively researching various aspects of learner control, this agenda will seek to explore the "transactional" (Merrill, 1985) effects of "dialoguing" with the system. The additional representational capabilities of the system extend the research from dialogue with computer generated text and animation to a dialogue with full audio and video fidelity from the videodisc. This leads to the following research question:

- What effect will cognitive engagement through instructional transactions with the full audio and video fidelity have on learning?

Text and visual data bases and cognitive schema. The main strength of the CBLS is its extensive storage capacity of both high fidelity audio and video, and computer data. The power of the system, however, lies in its computing capacity to manipulate the extensive stored data. These characteristics make it more feasible to research cognitive schema matching than it ever was before. Tapping in on the higher level information processing capabilities of the learner through assimilation and accommodation should result in a deeper understanding of the instruction. By first identifying the learner's organizational representation of the content in his/her own mind, two strategies can be explored. The first is to tie the new information to the existing patterns of thought in the learner. The second is to try to alter the patterns of thought to that of the "expert." In either case, visual or textual display can be manipulated by information from the original schema of the learner. Research questions specific to this topic include:

- What effect will matching existing cognitive schema with visual and textual data base information (reflecting either the expert or novice organization of information in the lesson) have on deep processing?

Graphic overlay and field dependence/independence. With graphic overlay capability, highly dense visual information

can be simplified, and very simple displays can be enhanced with the more realistic, dense visuals. This capability of manipulating the perceptual displays enables researcher to explore more fully the cognitive processing of field dependent and field independent learners. As Travers (1982) so aptly states, "The difference between the field-dependent and the field-independent person is particularly marked with respect to what is looked at and seen" (p. 75). Since field dependent and field independent learners process information either though global or detailed perspectives, the message form in terms of highlighting and sequencing of the density of the visual display could be manipulated to match their style of thinking. As a result, researchers can explore more fully the interaction of this cognitive style and display types. The following research questions are of interest:

- What effect does using graphic overlay have on learning for field dependent and independent learners?

- What effect does altering the sequencing of the display type have on learning for field dependent and independent learners?

Video windows and field dependence/independence. With the CBLS system, both video and text information can be displayed on the screen at the same time. Full motion video and audio can be played concurrently with the printed text from the computer. This capability offers great flexibility in the design of screen displays, but one area of relevance to this research agenda is its ability to display talking faces at the same time as text. While that may seem to be an inappropriate combination, given that another perceptual difference between field dependent and independent learners is their attention to people and faces, it follows that the addition of a more "human element" to the not-so-human computer environment may increase learning by field dependent learners, while the exclusion of these may enhance learning by field independent learners. The characteristics have led to the following research question:

- What effect will varying the inclusion and exclusion of a talking face to a text display have on learning by field dependent and field independent learners.

Alternate video and audio forms and modality strengths. Features of the systems which have been described in previous sections are also drawn upon in this section, but interrelated differently. The fact that we can store and manipulate large amounts of visual, auditory and textual data with relatively short computer processing time, enables the designers to store alternative modality presentation of the same material. The way this material is actually manipulated

for instructional display challenges designers, and is therefore an important area for research. Research has shown that individuals do not necessarily select the modality which matches their learning strengths, however, it has been inconclusive as far as system driven matched modality is concerned. Also of importance in the selection of modality, is whether matched modality is really better for learning since attention may suffer from viewing "easy" material. The need for more exploration of these issues led to the following research questions:

- o What effect does matching modality displays with modality strengths of learners have on learning?
- o What effect does mismatching modality displays with modality strengths of learners have on learning?
- o What effect does providing alternative modality presentation for those learners who are having difficulty have on learning?

Learner Control. A discussion of research with the CBLS would not be complete without recognizing the extreme importance of research on the interaction of learner control and all of the above variables. While this question is extremely important, it is the focus of many current studies of other researchers, and as such, will not be directly addressed in this list of questions. The results of those research studies will be carefully analyzed for applicability to these questions and where appropriate will be folded into the framework.

While we also realize that there are many more questions which could be addressed, we feel that we have selected some important "first issues."

Use of a Generic Research Disc

To conduct this research, we are proposing to follow the strategy Dwyer (1978) used to develop a series of guidelines for using realism in visual displays. Like Dwyer who developed nine general instructional treatments which varied level of realism from no visual to black and white line drawings to full color photographs of the heart, we will use a series of visual and auditory stimulus material which will be pressed onto a videodisc. The treatments for the various studies can, then, be altered through the sequencing, selecting of stimulus material (logic of the programming) and the addition or reorganization of text. By using this common set of visual materials, research results can be more legitimately synthesized.

In Dwyer's model, he selected a topic which would not be generally known to the population, as well as one which could be varied along the lines of levels of objectives. Following this lead, and also for very practical reasons, we have selected nutrition as the content area. Nutrition topics are of general interest, can be varied for level of objective, and for the most part, do not require too technical of prerequisite knowledge which would eliminate a major portion of the population. A large database of visual and auditory material currently exists. From this source, sequences appropriate to the research agenda will be selected for inclusion on the disc once specific outcomes have been specified. Their selection will be driven by the detailing of the research objectives listed above.

Maximum flexibility will also direct the selection of the final material to be pressed onto the generic research disc since the current agenda represents only a beginning of an evolving list of legitimate researchable questions possible with the computer based learning system.

Conclusion

The computer based learning system which currently can be described as combining interactive video and computer technologies offers new ways of displaying information to the learner. These new visual configurations enable researchers to examine how these perceptual displays can be matched effectively to the learner's information processing styles. Matching content and context, cognitive perceptual styles, and modality strengths have been highlighted out the myriad of potential question possible with this powerful medium and mark the beginning of continued exploration in this area.

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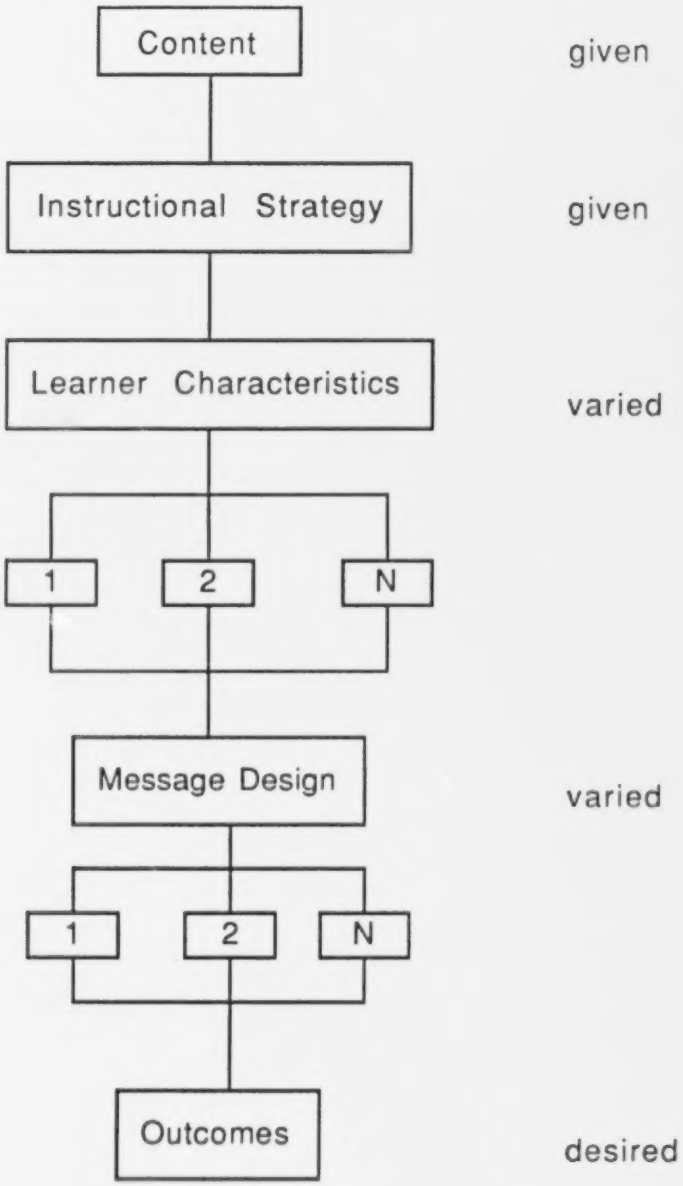
Content
given
Instructional Strategy
given
Learner Characteristics
varied
1
2
N
Message Design
varied
1
2
N
Outcomes
desired

Figure 1

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